Regional Difference of the Assortment of Daily Precipitation in Winter

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1 Introduction

It is well known that there is far more winter precipitation on the Japan Sea side than on the Pacific side. There are large differences between both areas not only in the normal precipitation but also in the stability of the precipitation (Kikuchi: 1972) and in the accordance-rate among the stations concerning the deviation sign of precipitation (Kikuchi: 1970). It is to be noticed that the deviation sign of winter precipitation on the Japan Sea side is opposite to that on the Pacific side in much more winters. The winter precipitation is the accumulation of daily precipitation, and the aspect of daily precipitation is different by area, therefore the variation of winter precipitation accords neither to the number of days with precipitation nor to the amount of daily precipitations. Asakura and Kuboki (1961) maintained that there is a linear correlation between the number of days with precipitation and the cubic root of total monthly precipitation, but the correlation coefficient is not so high.

On the Pacific side the precipitation days are very few, and it is fine on most days, however in rare cases there is heavy rain associated with the approach of atmospheric depressions or fronts, when the total precipitation is greatly affected by the heavy rain. On the Japan Sea side there is considerable precipitation on most days and there are only a few fine days in a month. There is not so large difference in such condition even if the winter precipitation is excessive or defficient, but there is a large difference in the number of days with heavy snow. The total precipitation is affected by heavy rain or snow in both areas, but the mechanism of heavy rain or snow in each area is quite different. Areas with heavy rain or snow are rather small and the locality of such areas seems to be fixed as a whole, therefore the total precipitation in the area without heavy rains is affected by the smaller daily precipitation.

2 Relation between the monthly precipitation and the daily precipitation

The assortment of the numbers of days in each class on the amount of daily precipitation and the sum of daily precipitation in each class are calculated for ten months with excessive precipitation and for ten months with deficient precipita-

Table Average number of days of ten months in each class of daily precipitation and the amounts of them

a) Months with excessive precipitation

Station \ daily precipitation(mm)		None	<1.0	1.0-9.9	10.0-19.9	20.0-29.9	30.0-49.9	50.0≦	Total
Miyako	Number of days	11.6	11.6	3.3	1.2	0.5	1.0	1.0	30.2
	Precipitation(mm)		1.0	11.2	16.4	13.2	39.8	82.0	163.6
	Percentage (%)		0.6	6.5	10.0	8.0	24.3	50.2	100.0
Morioka	Number of days	3.6	12.7	11.1	1.9	0.7	0.4		30.4
	Precipitation(mm)		2.0	47.9	25.3	20.0	13.9		109.1
	Percentage (%)		1.8	43.9	23.2	18.3	12.8		100.0
Takada	Number of days	2.2	3.0	7.1	6.4	4.4	4.8	3.1	31.0
	Precipitation(mm)		0.3	31.2	89.9	109.6	177.1	204.1	612.2
	Percentage (%)		0.0	5.1	14.7	17.9	28.9	33.4	100.0

b) Months with deficient precipitation

Station \ daily precipitation(mm)		None	<1.0	1.0-9.9	10.0-19.9	20.0-29.9	30.0-49.9	50.0≦	Total
Miyako	Number of days	13.6	13.4	2.4	0.2				29.6
	Precipitation(mm)		0.7	9.4	2.7				12.8
	Percentage (%)		5.2	74.0	20.8				100.0
Morioka	Number of days	4.1	17.7	7.3	0.8				29.9
	Precipitation(mm)		2.2	24.9	10.2				37.3
	Percentage (%)		6.0	66.8	27.2				100.0
Takada	Number of days	3.7	3.8	11.0	6.2	3.0	0.8	0.4	28.9
	Precipitation(mm)		0.3	50.1	89.2	69.5	28.0	21.9	259.0
	Percentage (%)		0.1	19.4	34.4	26.8	10.8	8.5	100.0

tion, respectively, at Miyako (on the Pacific coast), Morioka (inland) and Takada (on the Japan Sea coast) (Table).

At Miyako, about 50% of total precipitation in the month with excessive precipitation is brought by the heavy rains above 50 mm/day, and the sum of daily precipitations above 30 mm/day makes about three quarters of total precipitation. The number of days with precipitation does not change so greatly month to month, and the sum of daily precipitation below 10 mm/day is roughly equal both in months of excessive precipitation and in months of deficient precipitation. Therefore the heavy rains once or twice in a month greatly influence the fluctuation of monthly

precipitation. There is considerable precipitation on most days in winter on the Japan Sea side, and there is small difference at Takada between the numbers of days with precipitation in months with excessive precipitation and those with deficient precipitation. The sum of daily precipitations below 30 mm/day averages 231.0 mm for the ten months of excessive precipitation and 209.1 mm for the ten months of deficient precipitation. The difference in monthly precipitation is mainly due to the sum of daily precipitations above 30 mm/day, and such heavy precipitation occurs about seven times in a month of excessive precipitation, and once in a month of deficient precipitation.

The assortment of daily precipitation is very different from the above in Morioka. Here the heavy rain or snow is rare, and the amount is usually small on days with precipitation. The sum of daily precipitations below 20 mm/day reaches about 70% of total precipitation even in the month of excessive precipitation, though the number of days with precipitation does not vary so much month to month.

As above mentioned, there are wide differences in the distribution of the assortment of daily precipitation, therefore the direct mechanisms to which the difference of total precipitations is responsible may be different by respective region. Though the daily precipitation does not directly show the mechanism of the precipitation, if the pattern of the distribution of precipitation is the same under the same condition of atmosphere, the analysis of the assortment of daily precipitation will be very useful for the study of the mechanism of fluctuations of winter precipitation. From the viewpoint, the assortment of daily precipitation is compared among the areas to see the relation between the days with each class of daily precipitation and the total amount of winter precipitation. The assortment of daily precipitation is calculated with the data of 129 observation stations in three months, December, January and February, during 1951–60.

3 Assortment of daily precipitation

The assortment is calculated to compare the occurrence of daily precipitation as the ratio of the number of days in each class of daily precipitation against the total number of days with precipitation. The ratio of the number of days with precipitation below 1.0 mm/day (Fig. 1) is evenly below 20% on the Japan Sea side, and is above 45% in some inland areas. It is to be noticed that the highest ratio is on the east and south side of Backbone Range, the lee side of winter monsoon. These fine snow is considered to occupy a little part of heavy snowfall on the windward side, brought by the monsoon. Further from the Range, the fine snow becomes less frequent, and its ratio is low on the Pacific coast.

On the other hand, the ratio of the number of days with precipitation above

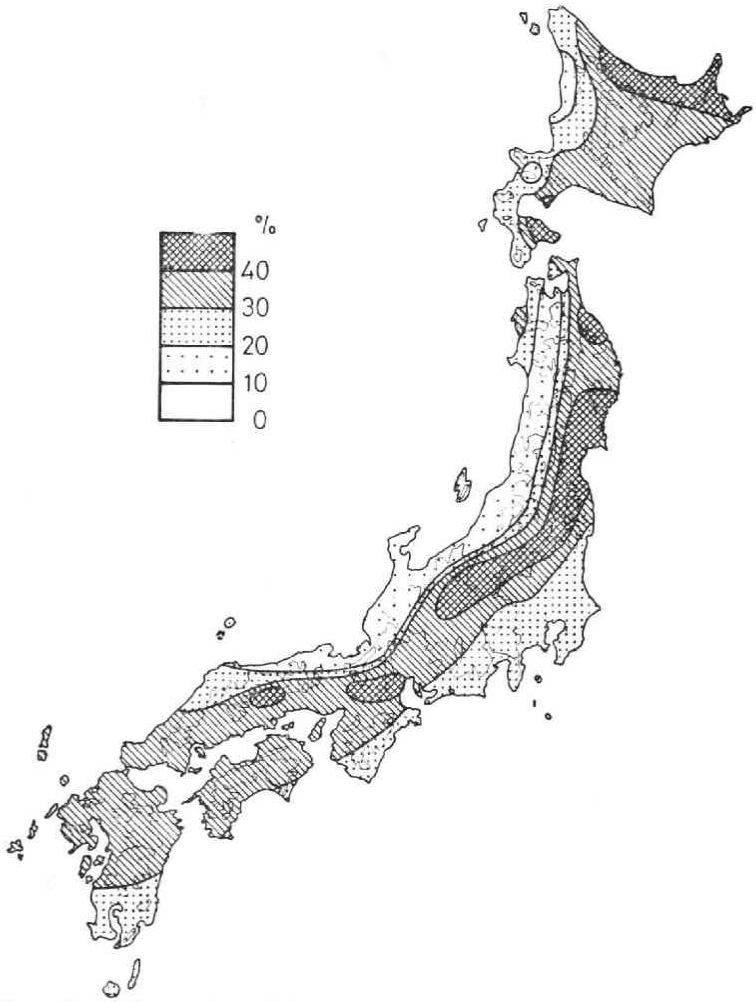

Fig 1. The ratio of the number of days with precipitation less than 1.0 mm/day against the number of days with precipitation equal to or more than 0.1 mm/day

10.0 mm/day (Fig. 2), which is assumed to be the lower limit of considerable daily precipitation (Kawamura: 1964), is 40% in the central part of Japan Sea side, so to say, the vast snow area, and on about 10% of the days there is the precipitation above 30 mm/day. The ratio decreases to the north or west on the Japan Sea side, which means that heavy snow is concentrated in comparatively small area. The ratio is generally low inland of Tohoku and Hokkaido, being below 10% in large part of Hokkaido. This fact suggests that heavy snow or rain in winter is rare in these areas, and most of winter precipitation in these areas is caused by different

Fig. 2 The ratio of the number of days with precipitation equal to or more than 10.0 mm/day against the number of days with precipitation equal to or more than 0.1 mm/day

mechanisms from those in the central part of Japan Sea side. The ratio is above 30% on the Pacific south coast to the west of Kanto, which is as high as on the Japan Sea side.

There is a clear contrast as above mentioned between the distribution of the ratio of the number of days with precipitation below 1.0 mm/day and above 10.0 mm/day against the total number of days with precipitation. Thus the aspect of daily precipitation is greatly different by area.

4 Types of assortment of daily precipitation

The higher ratio (such as above 30% of the number of days with precipitation above 10.0 mm/day against the total number of days with precipitation) appears both on the coasts of the Japan Sea and the Pacific south, however, between these two areas the number of days with precipitation is very different. The correlation between the total number of days with precipitation and the ratio of the number of days with precipitation above 10.0 mm/day, which are taken as the indices for the assortment of daily precipitation, is not clear. From the general view of all stations in Japan (Fig. 3), some groups of stations with similar assortment of daily precipitation are discernible. The method to decide the types of the assort-

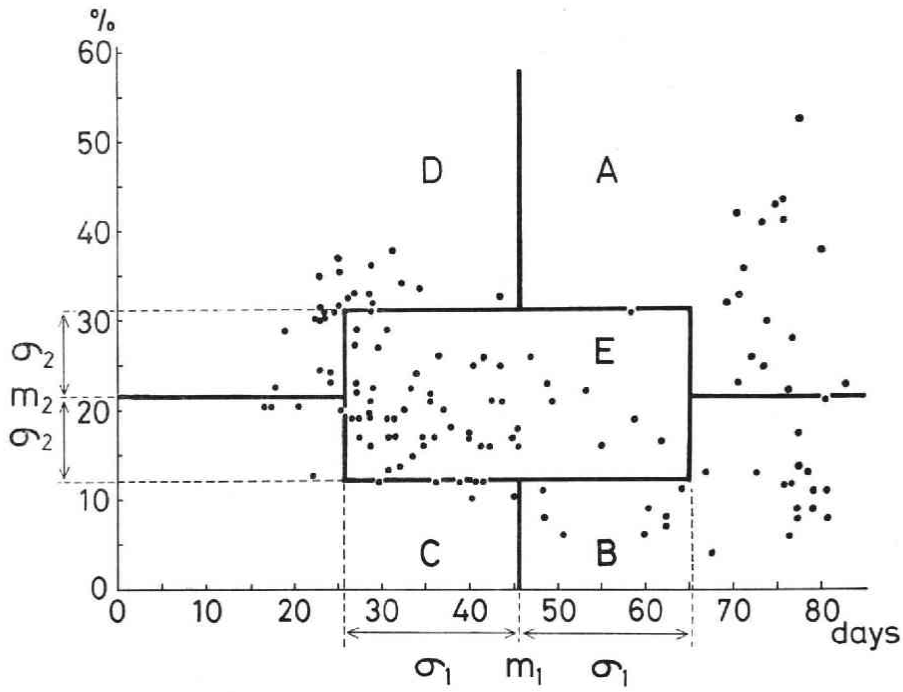

Fig. 3 The relation between the number of days with precipitation equal to or more than 0.1 mm/day and the ratio of the number of days with precipitation equal to or more than 10.0 mm/day against the number of days with precipitation equal to or more than 0.1 mm/day; and the types of assortment of daily precipitation

m_1: Mean of the number of days with precipitation equal to or more than 0.1 mm/day

σ_1: Standard deviation of the number of days

m_2: Mean of the ratio of the number of days with precipitation equal to or more than 10.0 mm/day against the number of days with precipitation equal to or more than 0.1 mm/day

σ_2: Standard deviation of the ratio

ment is as follows; assuming that the observation stations are distributed evenly in whole Japan, it follows that the stations with the values that fall in the standard deviations concerning the above mentioned two indices, may be considered to be the stations with normal assortment (Type E in Fig. 3). Thus the stations are divided into two groups: the stations with normal assortment (Type E) and the stations with large deviation, and the latter group is subdivided into four types according to the kinds of deviation. Then, the assortment of daily precipitation is classified into five types, A, B, C, D and E (Fig. 3).

The stations of each type are distributed to make some uniform areas about the assortment of daily precipitation (Fig. 4).

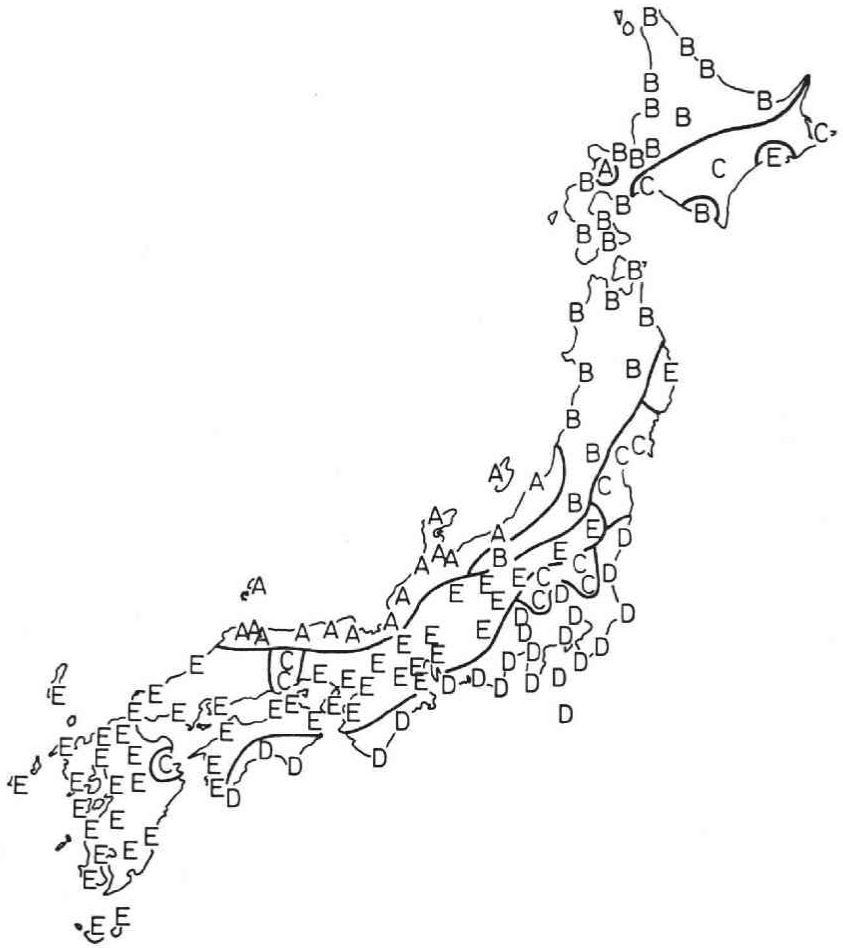

Fig. 4 Distribution of the types of assortment of daily precipitation

Type A: Both the indices above mentioned are high at 17 stations of this type distributed in the central and western part of the Japan Sea side, namely the stations have large number of days with precipitation and of heavy snow, resulting in a large quantity of total precipitation.

Type B: This type is characterized by the large number of days with precipitation and at the same time small daily precipitation. 25 stations in Tohoku except Pacific coast and in western Hokkaido belong to this type. The southernmost part of the area of this type is on the lee side of Type A area concerning winter monsoon. Though the precipitation is generally brought by the monsoon in this area as is the case in Type A area, the heavy snow rarely falls in this area. This is the different feature from the central part of the Japan Sea side.

Type C: This type is characterized by the small number of days with precipitation and low ratio of the number of days with precipitation above 10.0 mm/day. Only 13 stations in southeast Hokkaido, southeast Tohoku, north Kanto and Setouchi belong to this type. The number of stations is the least of five types, and the areas are small and separate. The deviations of both indices are comparatively small at the stations of this type.

Type D: This type is characterized by the small number of days with precipitation and high ratio of the days with precipitation above 10.0 mm/day. 23 stations along the Pacific coast from Kanto to Shikoku belong to this type, and the area is narrow in the west and wide in the east including the inland Kanto.

Type E: This type is characterized by the normal assortment of daily precipitation. 51 stations mainly in west Japan, that is whole Kyushu, Setouchi, and inland Kinki and Chūbu, belong to this type. The area of this type is wide in the west and becomes norrower to the northeast, and only two stations are in north Japan.

Generally speaking, types of large number of days with precipitation (Type A and B) are located in the Japan Sea side and types of small number of days with precipitation (Type C and D) are located in the Pacific side. Types of high ratio of the days with precipitation above 10.0 mm/day (Type A and D) are located relatively southern region and the types of low ratio of that (Type B and C) are located northern region and inland.

5 Summary

Regional difference in Japan about the daily precipitation is found as follows.

1) The difference between the months with excessive and deficient precipitation is due to the heavy snow and rain above 30.0 mm/day in the central part of Japan Sea side and on the Pacific coast, but inland north Japan without heavy snow or rain, it is due to the accumulation of small daily precipitation.

2) The assortment of daily precipitation is classified into five types according to the number of days with precipitation and the ratio of the days with precipitation above 10.0 mm/day against it, and each of types has respective area.

3) The central part of Japan Sea side has any precipitation in most days and frequent heavy snow. Tohoku and north and west Hokkaido also has usually little precipitation in most days but rare heavy snow. On the Pacific coast the days with precipitation is relatively few but sometimes it rains heavily. Larger part of western Japan and inland Honshu has the average number of days with precipitation and the average ratio of the days with precipitation above 10.0 mm/day against it.

4) The Japan Sea side has the types of large number of days with precipitation (Type A and B), and the Pacific side has the types of small number of days with precipitation (Type C and D). Southern Japan has the types of high ratio of the days with precipitation above 10.0 mm/day (Type A and D), and northern Japan has the types of low ratio (Type B and C).

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